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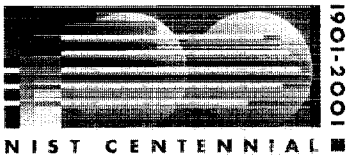
VOLUME 1

Sheilda L. Bryner, Editor



National Institute of Standards and Technology
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U. S. Department of Commerce
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Technology Administration
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Development of Pneumatic Atomizing Gun for Fire Fighting

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Abstract

During indoor fire fighting in multiple dwelling houses, water damage (breaking of furniture, etc. and leakage to the first floor by excess water) is a significant problem. Therefore, we are developing the Pneumatic Atomizing Gun (PAG) for Fire Fighting which can reduce the required water quantity. This method atomizes water and air at the same time. Because water is atomized using a high-speed air flow, the particle diameter of drops of water is fine, and at the same time, range of the particles can be raised. As a result of the comparison test to confirm the fire fighting capacity, equal flames were extinguished by a water quantity about 1/6 of that from the existing project gun. It was assumed that fire fighting using a small quantity of water contributed by increasing the heat exchange efficiency due to the fineness of the water particles, and at the same time, satisfying the improvement in efficiency by reaching the origin of the fire using water particles which were not easily fanned by the flames.

Background

Water damage (breaking of indoor furniture, etc., and leakage to the first floor by excess water) to houses has becomes a great problem for indoor fire fighting in multiple dwelling homes and office buildings. At present, the Impulse Gun, Project Gun (Fog Gun), etc. which use a small quantity of water for projecting against water damage are used. However, the former cannot continuously spray water and the latter requires a high water pressure and the use of those guns is limited due to insufficient water pressure during fire fighting in multiple floors. Each gun has certain faults (Table 1). Also, there are potential problems that the fine drops of water are difficult to reach the origin of a fire.

On the other hand, PAG, which is used as a snow gun, etc., of an artificial snowfall machine, can continuously atomize water at low pressure and can overcome the fault of the existing water-saving type nozzle. The direct spraying of fine water particles is extremely superior to that of a nozzle atomizing only water. By using this for fire fighting, a great effect can be expected for preventing water damage. Therefore,

the fire fighting test was performed in order to confirm the fire fighting capacity and them compared with the existing water-saving type nozzle.

Table 1. Comparison of water-saving type fire fighting nozzle

	Structure	Continuously spouting water	Atomizing at low water pressure*
Inpluse Gun	Spouting water by high pressure air	×	○
Project Gun (Fog gun)	Atomizing water by high pressure	○	×
PAG	Atomizing water and air at the same time	○	○

*···About 500kPa taking in account fire fighting, etc., at high altitude.

PAG for Fire Fighting

PAG is a gun atomizing liquid and air at the same time. In the nozzle section inlets of liquid and air are separately installed. After the liquid and air are mixed in the nozzle body, both are sprayed from the injection nozzle. PAG has in general the following features.

- Atomizing is possible at low pressure. Since PAG atomizes a liquid by using a high-speed air flow, it can atomize drops into liquid of fine particles at a relatively low pressure.
- Particles have highly direct flow···Since drops of liquid are injected into the air flow, the speed is difficult to be reduced and a direct spray is quite excellent compared with atomization of the liquid only.

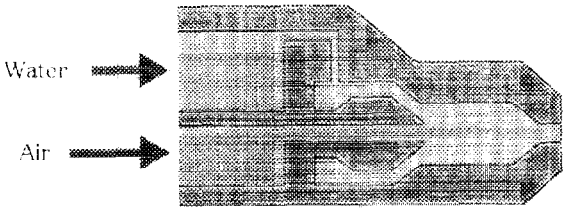

Fig. 1 Concept of PAG

The PAG having those features is considered to be quite suitable for fire fighting using a small quantity of water for the following reasons.

- The conventional project gun (fog gun) is used at 1~1.5MPa and the problem is that the usual pump vehicle and the working pressure for fire fighting at high altitudes cannot be obtained, but PAG can be used at a low pressure of about 500kPa.

- When particle diameter of water is made fine, the heat exchange efficiency of the flame and water is improved and fire fighting with a smaller water quantity may be possible. However, fine water particles, in general, are easily fanned by flames and the amount reaching the origin of a fire is low. However, since the direct spraying of particles from a PAG is excellent, even fine drops of water has a high coefficient of reaching the origin of a fire. At the same time, PAG can satisfy fine drops of water and improving the coefficient reaching the origin of a fire which are two opposite requirements.

To confirm the capacity of the PAG as a water damage prevention-type fire nozzle, the fire fighting test was performed.

Test Goal

The goal of this test is to confirm the fire fighting capacity of the PAG and compare it with the conventional water-saving nozzle. Therefore, fire from the same burning models are actually extinguished using the Project Gun and PAG, and the fire fighting status was observed. Burning models woods were used assuming an indoor fire (combustibles are furniture, interior, etc.) in multiple dwelling houses. The test procedure is as follows.

(1) Burning models are installed in a dummy house. The burning models are constructed of wood above the burning bases in which 2 liters each of gasoline and kerosene are included.

(2) 5 minutes after starting the models on fire, the fighting is started. At this time the fuel was burnt and only the wood was burning.

(3) The Project Gun and PAG extinguish the fire from the same position. The directions of the spouting water were varied up and down, left and right and water was sprayed from all angles on the burning models. Tests included 1 case of the Project Gun ···184 (l/min.) and 4 cases of the PAG ··· 20, 30, 10, 60(l/min.)-5 cases in total were performed.

(4) At the time when the burning models have no flame, the fire fighting was finished. When no flames were found, it was recognized that the fire fighting had finished. When flames are found, water is sprayed until flames cannot be found.

The measured items are water flow rate and the time required for fire fighting. In the PAG, the air flow rate is also measured. The state of flame and fire fighting status are separately observed.

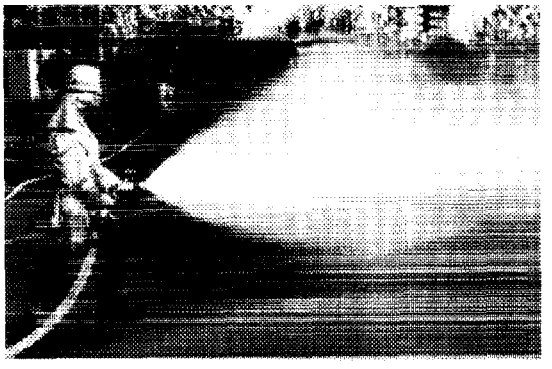

Fig. 2 Project Gun

Fig. 3 PAG (under development)

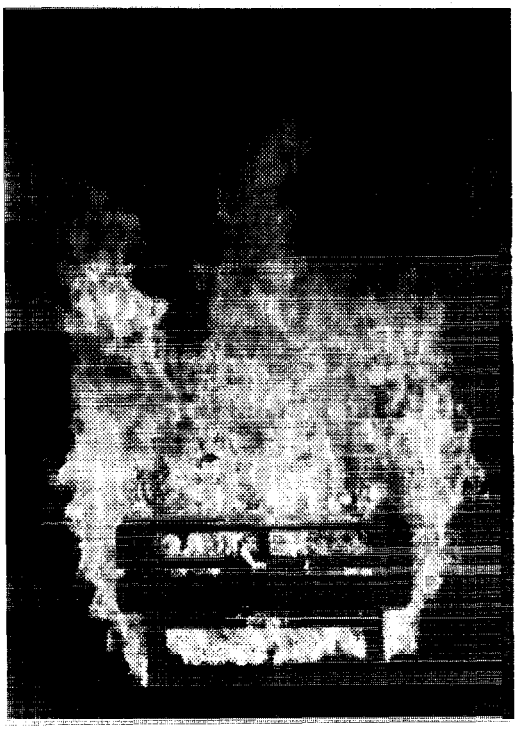

Fig. 4 Burning model

Test Results

In this test, both guns spray water from a fixed point so that the test conditions are the same. Therefore, it takes somewhat longer time to completely extinguish a fire in a blind spot of the burning models although fire in a blind spot can be usually extinguished by going around the blind spot. However, when it is included into the test results, this may be causes of increasing of the experimental error and is not adequate. Therefore, in this test, completion of the fire fighting is specified to be the time when the flames of the burning models cannot be found, and the time and water quantity required for the above status are then recorded.

Table 2 shows the test results. It could be confirmed based on the test results that the PAG can properly extinguish a fire. Furthermore, it was suggested that the optimum value of fire fighting water quantity existed at about 10 (l/min). A future investigation is required to evaluate the influence of the burning models and the air and water ratio.

Next the time and water quantity required for fire fighting using the Project Gun (case 1) and PAG (case 4) were compared (Fig. 5). From the comparison, it became clear that when the PAG was used for fire fighting, the water quantity required for fire fighting was overwhelmingly less and was about 1/6 that of the Project Gun, and the

PAG was effective as a water damage prevention nozzle. The time required for fire fighting is also reduced. The following factors have influence on these results

- When PAG is used, water particles can be atomized and the heat exchange efficiency at the origin of a fire is high.
- Because the force of the water particles is strong and surely reach the origin of a fire. The fire fighting efficiency is high.
- Because the force of the air and liquid mixed flow is strong, blowing out is also effective.

Table 2. Fire Fighting Test Results

case	Gun	Water quantity Qw (l/min)	Air quantity Qa (Nl/min)	Qa/Qw	Required for fire fighting		Fire fighting status
					Time (sec)	Water quantity (l)	
1	Project Gun	184	-	-	55	169	Fire fighting is possible.
2	PAG	21	1740	82.9	-	-	Fire fighting is impossible.
3	PAG	30	1280	42.7	112	56	It took a significant time to extinguish a fire in a blind spot.
4	PAG	40	950	23.8	40	27	Fire fighting is possible. Blowing out is highly effective.It is required to go around to a blind spot.
5	PAG	60	500	8.3	43	43	Fire fighting is possible, but there is no remarkable superiority compared with 40(l /min)

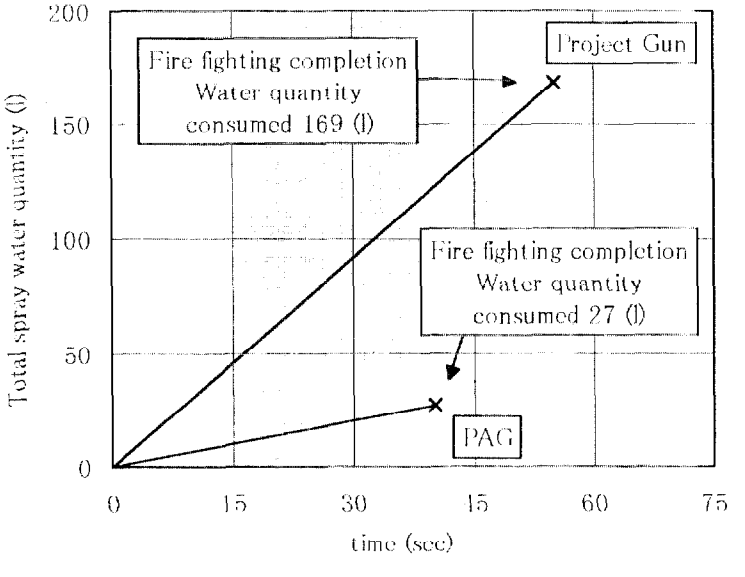

Fig. 5 Comparison of fire fighting status between Project Gun and PAG

Conclusion and Future Development

The fire fighting test was conducted using the PAG in which a reduction of water damage was expected when fire fighting indoor fires. The PAG was compared with the existing water damage prevention nozzle. As a result, it was clarified that when the PAG was used for fire fighting, the water quantity required for fire fighting was about 1/6 that of the Project Gun and was overwhelmingly less. The time required for fire fighting was also reduced and the outlook for putting this system to practical use was obtained. It is expected that a detailed study of the compressor section, hoses conveying the water and air that are loaded on a fire engine and the gun structure will be made for putting this system into practical use, and development of the PAG for fire fighting is completed.

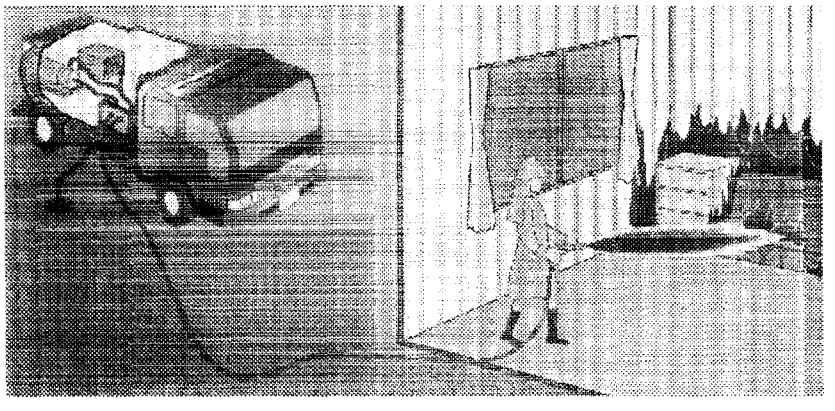

Fig. 6 PAG for Fire Fighting and Concept of System

Reference

[1] Japanese Association of Fire Science and Engineering: Fire Handbook (3rd Edition), Kyoritsu Shuppan 1985